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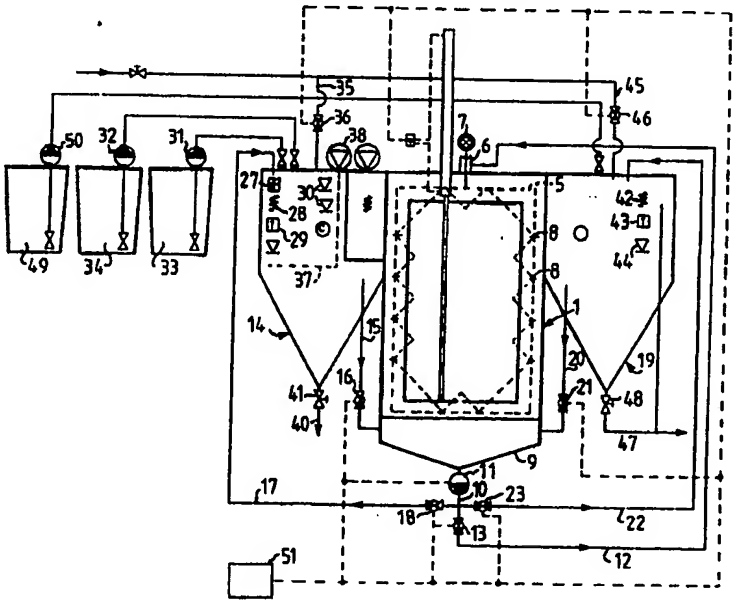

(57) Abstract

The invention relates to a device for cleaning objects, preferably of metal, for removal of contaminants, such as oil, grease, solid particles and the like by using a washing liquid containing, on the one hand, an active detergent, and, on the other hand, microorganisms for reducing the contaminants transmitted from the objects to the washing liquid. The device comprises a washing chamber (1) with supporting means for at least one object, to be cleaned, and means (5, 8) to provide contact between the washing liquid and the objects. According to the invention, a washing liquid container (14) is disposed outside the washing chamber (1), and a supply line (15) and a return line (17) are arranged between the washing liquid container (14) and the washing chamber (1) for supply of washing liquid to the washing chamber (1) and for return of washing liquid to the washing liquid container (14). Means (11, 16, 18) are also arranged in the supply line (15) and/or the return line (17) to transfer a controlled amount of washing liquid from the washing liquid container (14) to the washing chamber (1) at the beginning of cleaning cycle and for transmission of the washing liquid from the washing chamber (1) to the washing liquid container (14) at the end of the cleaning cycle.

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A DEVICE FOR CLEANING OBJECTS, PREFERABLY OF METAL

The invention relates to a device for cleaning objects, preferably of metal, in accordance with the preamble to Claim 1.

The cleaning or washing or objects is used in many different contexts, primarily as a preparation for surface treatments of various types. The purpose of the cleaning is to provide a clean surface from which oil, grease, proteins, carbon, graphite, slag etc. have been removed, so that the subsequent surface treatment will not be affected. The conventional cleaning methods for this purpose can be divided into two main groups, namely wet cleaning methods and solvent-based cleaning methods.

Wet cleaning methods comprise alkaline, acidic and biological cleaning methods, while solvent-based cleaning methods are usually based on trichloro ethylene, methylene chloride or freon.

Amongst the wet cleaning methods, the alkaline methods, which are based on sodium hydroxide and emulsifiers predominate. This cleaning method has initially a very good cleaning capacity, but the capacity drops quite sharply after a very short period of operation as a result of the fact that substances washed off the objects accumulate in the washing liquid. The washing liquid is usually kept at a relatively high temperature, which is necessary as a result of the fact that the enriched contaminants limit the effectiveness of the washing liquid. One problem in this context is achieving a good method of cleaning the washing liquid. Except for cracking and precipitating the oil content, there is no other effective method and the washing liquid must be replaced when the oil content in the same has reached about 1%. It is, however, uncommon to

do this since the costs are high to take care of the contaminated washing liquid and for energy consumption, since the working temperature is normally about 70°C. For this purpose, the washing liquid is usually only replaced when the cleaning capacity has dropped to a very low value.

The acidic cleaning methods are usually based on phosphoric acid with a relatively large content of emulsifiers. These methods have replaced the alkaline cleaning methods for, for example, hot-dip galvanizing, since they are cheaper than other methods. In acidic cleaning methods, the oil is cracked and the emulsified oil forms small aggregates which sink to the bottom of the washing liquid. In this type of cleaning method, it has been attempted to separate the washing liquid from the emulsified oil particles, but no appreciable increasing effectivity has been achieved beyond a somewhat longer life for the washing liquid. Furthermore, the acidic cleaning methods do not have a very high capacity, which is a result of the fact that the methods are performing at room temperature, which is a precondition for the oil and grease to be able to emulsify and sink to the bottom. Increasing the temperature would also increase the pickling activity of the washing liquid, which is relatively low when the method is performed at room temperature.

In both the alkaline and the acidic cleaning methods, the objects are difficult to rinse because a portion of the washing liquid accompanies the objects to the rinsing. In the alkaline methods, sodium hydroxide and oil accompany the objects and they are difficult to rinse from the cleaned surface of the objects. In the acidic cleaning methods, emulsified oil particles, which are relatively large and have an uneven emulsifying shape, accompany the objects, and this type of contaminant together with acid is very difficult to rinse off.

The biological cleaning methods utilize in an excellent manner the activity and capacity of the used detergent by continuously reducing the contaminants supplied to the washing liquid, such as oil, grease, biological substances, proteins, graphites, carbon, slag etc. The active detergent consists essentially of a custom-made tenside, the function and stability of which is preserved continuously. The capacity is thus very high compared to conventional alkaline and acidic cleaning methods. This is due to the fact that in the biological cleaning methods, detergents are used which at low temperature are able to dissolve oil, grease, biological substances etc. The biological cleaning methods are therefore superior to the other methods. From an economic point of view, the biological cleaning methods are preferable, since the costs therefor are only 25-40% of the costs for wet or solvent--based cleaning methods.

The solvent-based cleaning methods, which are essentially based on trichloro ethylene or methylene chloride, dissolve the oil and grease by a vapourized solvent. The cleaning capacity is good, and the contaminants added to the cleaning liquid can be collected as a bottom slurry after condensation of the vapour solvent. These methods have great advantages by virtue of the fact that the solvent penetrates into small hidden spaces and there dissolve all grease on the surface of the objects. These methods have, however, the limitation that they only work on soluble substances, such as oil and grease, while biological substances, proteins, graphite, carbon, slag etc. cannot be removed by these methods and essentially remain on the surface of the objects. From the point of view of costs, these methods are essentially comparable to the wet alkaline methods.

From an environmental point of view, the wet alkaline methods are problematic, since they normally work at a

temperature of about 70°C and the washing liquid often has a soda content of about 5-15%. The washing liquid must be sent to a waste processor, since it has a high content of oil and sodium hydroxide. The biological washing methods operate in a completely closed system and they do not produce any toxic substances and are thus to be preferred from an environmental point of view.

In the solvent-based cleaning methods, the cleaning devices must be entirely enclosed, which means that the devices must be provided with carbon or zeolite filters or with a biological scrubber. This involves high costs, and since most of these devices are relatively small, the costs may be prohibitive.

In complicated cleaning processes, where the material contains small enclosures, capillaries etc., freon has often been used, but this is becoming less and less frequent as a result of increased environmental standards. The solvent-based cleaning methods have, however, appreciable advantages for cleaning objects which are to be painted, since small hidden cavities will always be dry and free of cleaning liquid. This is an absolute precondition for cleaning with trichloro ethylene, which must not under any circumstances remain on the objects during a subsequent welding operation, for example, since trichloro ethylene at elevated temperature produces very poisonous gases.

The purpose of the invention is to provide a device for cleaning objects, preferably of metal, said device making it possible to use a biological cleaning method in an effective method. This is achieved according to the invention by means of a device of the type described by way of introduction, which is characterized by the features disclosed in the characterizing clause of Claim 1.

Preferred embodiments of the device according to the invention are disclosed in the subclaims.

The invention will be described in more detail below with reference to the accompanying drawings, of which
Figure 1 is a schematic diagram of a device according to the invention,
Figure 2 is a somewhat schematic, partially cut-away side-view of a device according to one embodiment of the invention,
Figure 3 is a view from above of the device according to Figure 2, and
Figure 4 is a front view of the device shown in Figures 2 and 3.

The drawings show a device according to one embodiment of the invention. Figure 1 shows the device in schematic form with certain portions moved apart to more clearly show the functional relationship between the various components.

The central portion of the device is a washing chamber 1, which is closed but provided with a cover 2, which can be opened for insertion of objects into the washing chamber 1 for washing and removal of objects. In the chamber 1, there is a support 3 for the objects to be cleaned. The objects can, for example, be loaded on carts which are pushed on a roller conveyor 4 into the chamber 1.

Inside the chamber 1, there is a pipe loop 5 hung on a mounting 6 in the upper portion of the chamber 1. The pipe loop 5 is rotatably mounted in the mounting 6, and outside the chamber 1 there is a motor 7 for imparting a rotary movement to the pipe loop 5 in the chamber 1 via a suitable gearing arrangement.

The pipe loop 5 is provided with a number of nozzles 8, which are directed essentially inwardly towards the axis

of rotation of the pipe loop and through which liquid from the pipe loop can be sprayed at objects in the washing chamber 1.

The chamber 1 is made with a conical or downwardly narrowing bottom portion 9, and from its lowest point there extends a drain pipe 10. A pump 11 is arranged in the drain pipe 10, and downstream of the pump 11 a circulation line 12 with a control valve 13 extends from the drain pipe 10 to the mounting 6 of the pipe loop 5 at the upper portion of the chamber 1. The circulation line 12 thus has flow communication via the mounting 6 with the pipe loop 5.

Adjacent the washing chamber 1 there is a cleaning liquid container 14, which is designed to hold cleaning liquid and which is provided with means for controlling the composition of the cleaning liquid, and this will be described in more detail below. From the cleaning liquid container 1 a supply line 15 with a control valve 16 extends to the bottom portion 9 of the chamber 1. From the drain line 10 downstream of the pump 11, a return line 17 extends via a control valve 18 to the upper portion of the washing liquid container 14.

Outside the chamber 1 there is also a rinsing liquid container 19, from which a supply line 20 with a control valve 22 extends to the bottom portion 9 of the chamber 1. From the drain line 10 downstream of the pump 11, a return line 22 with a control valve 23 extends to the upper portion of the rinsing liquid container 19. The rinsing liquid container 19 is also provided with control means for preserving the properties of the rinsing liquid, and this will be described in more detail below.

Adjacent the washing chamber 1 there is also a dryer unit 24 with a fan 25 and a duct 26 for blowing in hot air for drying the objects in the washing chamber 1.

A cleaning cycle in the device described above according to the invention can be performed as follows. First, the objects to be cleaned are placed in the washing chamber 1, on the support 3. The cover 2 is closed so as to seal the washing chamber 1. Thereafter the control valve 16 is opened so that washing liquid from the washing liquid container 14 flows into the bottom portion 9 of the chamber 1. When a sufficient amount of washing liquid has flown into the washing chamber 1, the control valve 16 is again closed. Thereafter, the control valve 13 is opened and the pump 11 is started. The control valves 18 and 23 are kept closed. The motor 7 is started to rotate the pipe loop 5 and the washing liquid in the chamber 1 is circulated through the circulation line 12 into the pipe loop 5 from which it is sprayed through the nozzles 8 under high pressure into contact with the objects in the washing chamber 1 to clean the same.

After completed washing of the objects, the control valve 13 is closed and the control valve 18 is opened so that the pump 11 then returns the washing liquid from the bottom portion 9 of the chamber 1 to the washing liquid container 14. The washing cycle proper is thus completed, and the objects, after opening of the cover 2, can be removed from the chamber 1.

If so desired, before the objects are taken out of the chamber 1, they can be rinsed by opening the control valve 21 for introducing rinsing liquid, usually water, from the rinsing liquid container 19 through the supply line 20 to the bottom portion 9 of the chamber 1. After closing the control valve 21 and opening the control valve 13, as well as starting the pump 11 and the motor 7, rinsing liquid is sprayed through the nozzles 8 on to the objects for rinsing the same and removing any residue of washing liquid. After the completed rinse cycle, the control valve 13 is closed and the control valve 23 is opened, so that

the rinsing liquid from the bottom portion 9 of the chamber 1 can be returned to the rinsing liquid container 19 via the return line 22.

Washing with optional rinsing of steel objects provide an absolutely clean surface of the steel, and this involves a risk of oxidation. In order to avoid this as much as possible, the dryer unit 24 is used, which blows in hot air through the duct 26 in order to quickly dry the objects in the chamber 1.

As mentioned above, the washing liquid container 14 and the rinsing liquid container 19 are provided with control means for preserving the properties of the washing liquid and the rinsing liquid to thereby provide optimum performance. The washing liquid should be kept at a predetermined pH-value and optimum temperature. Furthermore, the contaminants coming from the objects in the washing chamber 1 as well as dead micro organisms must be able to be separated from the washing liquid, as they would otherwise be accumulated to toxic concentrations making biological life in the washing liquid impossible. For this purpose, the washing liquid container 14 has a pH-sensor 27 and a heater 28 with a thermostat 29. Furthermore, the washing liquid container 14 has level sensors 30, which sense the level of the washing liquid and provide signals if the level exceeds predetermined limits.

The pH-sensor 27, the heater 28 with the thermostat 29, and the level sensors 30 are coupled to a control system (not shown) which, in response to the readings from the washing liquid container 14, control pumps 31 and 32 to supply detergents or nutrients from container 33 or 34 to the washing liquid container 14. Furthermore, an inlet line 35 with a control valve 36, supplies, in response to signals from the level sensors 30, fresh water to the washing liquid container 14.

The washing liquid container 14 is also provided with an air-duct 37, through which a fan 38 can supply air to the washing liquid container 14 to provide oxygen to the washing liquid. Continuous supply of oxygen with the aid of the fan 38 and the duct 37 makes it possible to maintain active fermentation in the washing liquid, the continuous supply of oxygen maintaining an aerobic biological system in the washing liquid container 14.

By providing the steady state for the washing liquid in the container 14, i.e. controlled pH-value, controlled temperature and with the supply of nutrient additives, an active biological bacteria growth is obtained feeding on the contaminant supply, such as oil, grease, organic material etc. The nutrient additives contain magnesium, potassium, sulphates, phosphates, ammonia, chlorides and glycose, and are supplied to the washing liquid in suitable amounts, so that an active fermentation can be based thereon.

During fermentating small amounts of carbonic acid are formed, which are evacuated through an exit duct 39. A slurry of dead bacteria and contaminants is also formed, accompanying the washing liquid from the objects in the washing chamber 1. This slurry is allowed to settle in the lower portion of the washing liquid container 14, which is conical and is located below the duct 37, so that in this lower portion a region is formed without any significant movements in the washing liquid. Contributing to this is the fact that the supply line 15 removes washing liquid at a relatively high level from the washing liquid container 14. At the very bottom of the washing liquid container 14, there is a drain pipe 40 with a valve 41 which enables the settled slurry to be removed from the container 14. This should be done continuously or at short intervals in order to prevent anaerobic bacteria growth, which otherwise occurs relatively rapidly.

The rinsing liqud container 19 is provided with a heater 42 with a thermostat 43 as well as a level sensor 44. These components are also coupled to a control system, which controls the conditions in the rinsing liquid container 19. An inlet line 45 with a control valve 46 makes it possible to supply fresh water to the rinsing liquid container 19. The rinsing liquid container 19 has a conical lower portion and at the very bottom there is a drain pipe 47 with a valve 48, for removal of contaminated rinsing liquid from the lower portion of the rinsing liquid container 19. Furthermore, there is a container 49 for an anti-corrosive agent, which as needed can be introduced via a pump 50 into the rinsing liquid container 19 to protect against corrosion of the rinsed objects in the washing chamber 1.

Figure 1 also shows schematically a control unit 51, to which the control valves 13, 16, 18, 21, 23, 36 and 46, as well as the pump 11, are connected. The control equipment in the washing liquid container 14 and in the rinsing liquid container 19 can also be coupled to this control unit, but these can of course also be controlled by separate control units.

After starting the device and during constant use thereof, with objects being supplied to be washed in the washing chamber 1, whereupon washing liquid absorbs contaminants from the objects, the supply of detergent is controlled at a level which is as low as possible for achieving effective cleaning. Under these conditions, after a short period of time, equilibrium is achieved between the contaminants introduced and the detergent, and the device can work satisfactorily with a detergent content in the washing liquid which is as small as 0.5%. This means that the washing liquid will be clear with the lowest possible content of detergent and contaminants, thus providing an effective cleaning function, leaving the washed objects

with a clean surface in a closed system. This means that the objects will be as close to absolutely clean as possible and will often not require any subsequent rinsing.

If rinsing is required, for example if it is required that the surface of the objects be very clean for subsequent painting, the rinsing is carried out in the manner described above. By virtue of the fact that the washing liquid is free of contaminants and has a very low content of detergent, very little detergent and contaminants will be introduced to the rinsing liquid during rinsing. This means that the rinsing liquid can be kept pure, and this is improved additionally by supplying a suitable amount of fresh water to the rinsing liquid after each rinsing cycle to fill up the rinsing liquid container 19. The rinsing liquid exiting through the drain line 47 thus has a very low content of oil and detergent. For example, an oil content of 0.1-10 mg/l and a detergent content of 0.5-15 mg/l.

The device described above for cleaning objects is very effective and it can operate in a practically closed system requiring minimal amounts of detergent, the washing liquid being reusable a large number of times. This means that the use of the washing liquid will be very effective and thus very inexpensive.

CLAIMS

1. Device for cleaning objects, preferably of metal, for removal of contaminants, such as oil, grease, solid particles and the like, by using a washing liquid containing, on the one hand, an active detergent, and, on the other hand, microorganisms for reducing the contaminants transmitted from the objects to the washing liquid, said device comprising a washing chamber (1) with support means (3) for at least one object to be cleaned, and means (5, 8) for providing contact between the washing liquid and the objects, c h a r a c t e r i z e d in that a washing liquid container (14) is arranged outside the washing chamber (1), a supply line (15) and a return line (17) being arranged between the washing liquid container (14) and the washing chamber (1) for supply of washing liquid to the washing chamber (1) and for return of washing liquid to the washing liquid container (14), as well as means (11, 16, 18) arranged in the supply line (15) and/or the return line (17) for transmitting a controlled amount of washing liquid from the washing liquid container (14) to the washing chamber (1) at the beginning of a cleaning cycle and transmission of washing liquid from the washing chamber (1) to the washing liquid container (14) at the end of a cleaning cycle.

2. Device according to Claim 1, c h a r a c t e r - i z e d in that the washing chamber (1) has a bottom portion (9) for washing liquid, and that a pump (11) is disposed to pump washing liquid from the bottom portion (9) to at least one nozzle (8) in the washing chamber (1), through which nozzle (8) washing liquid is sprayed onto the objects to be cleaned.

3. Device according to Claim 2, c h a r a c t e r - i z e d in that a plurality of nozzles (8) is arranged in

the washing chamber (1), said nozzles (8) being placed on a pipe loop (5) which is rotatably mounted in the washing chamber (1).

4. Device according to one of Claims 1-3, c h a r a c t - e r i z e d in that the washing liquid container (14) is provided with a downwardly tapered, essentially conical bottom for sedimentation of material from the washing liquid, said washing liquid container (14) having at its lowest point a drain pipe (40) for removing sedimented sludge.

5. Device according to one of Claims 1-4, c h a r a c t - e r i z e d in that the washing liquid container (14) is provided with an air supply duct (37) which is disposed above the conical bottom portion, a fan (38) being arranged to force air through the air supply duct (37) for oxygen supply to the washing liquid in the upper portion of the washing liquid container (14).

6. Device according to one of Claims 1-5, c h a r a c t - e r i z e d in that dryer unit (24) is arranged adjacent the washing chamber (1) to blow hot air into the washing chamber (1) to dry objects therein.

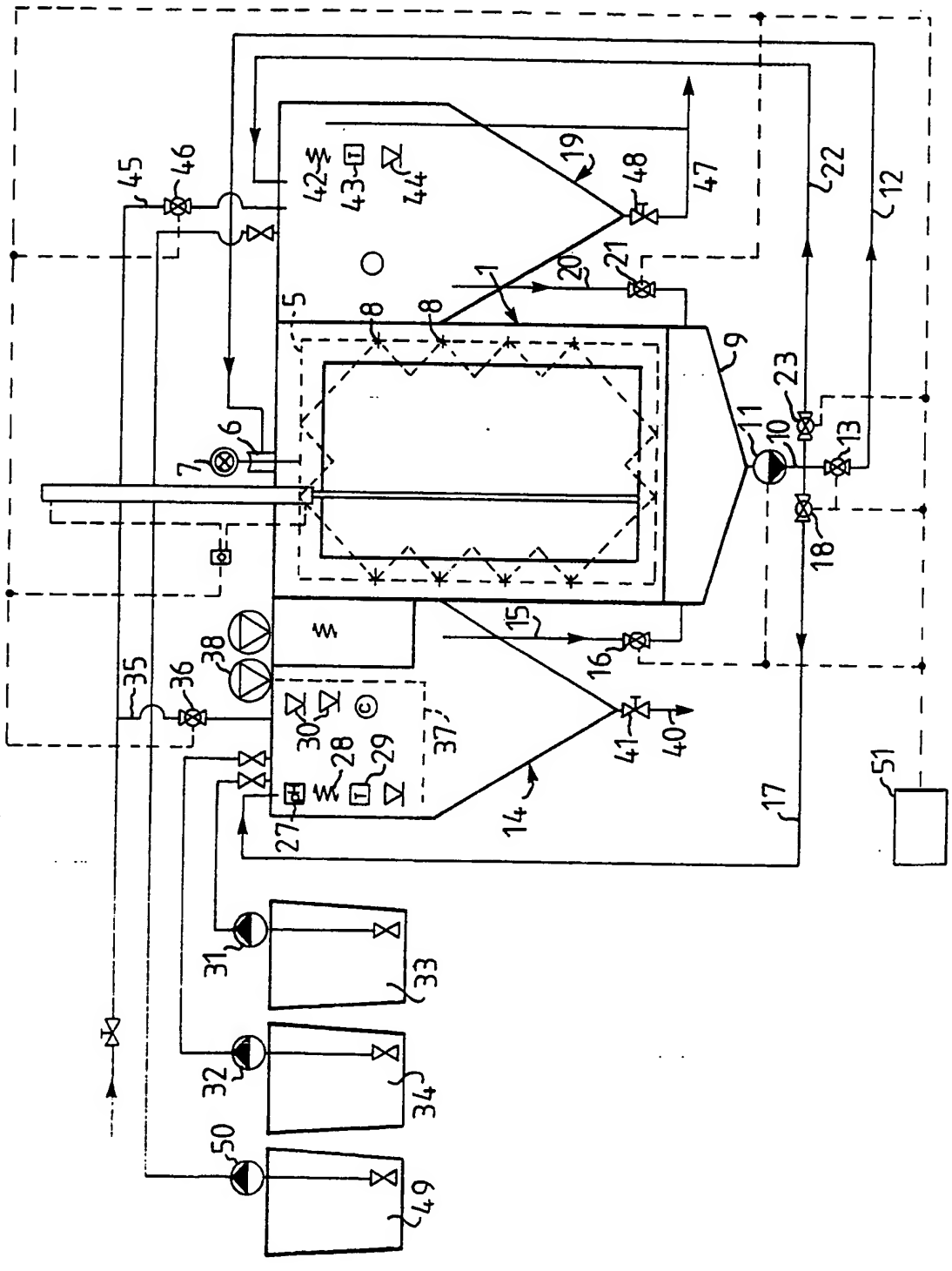
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FIG.1

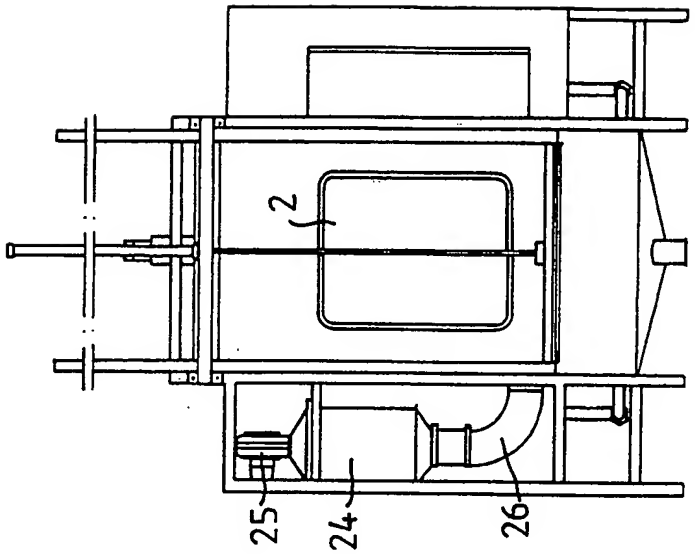

FIG.4

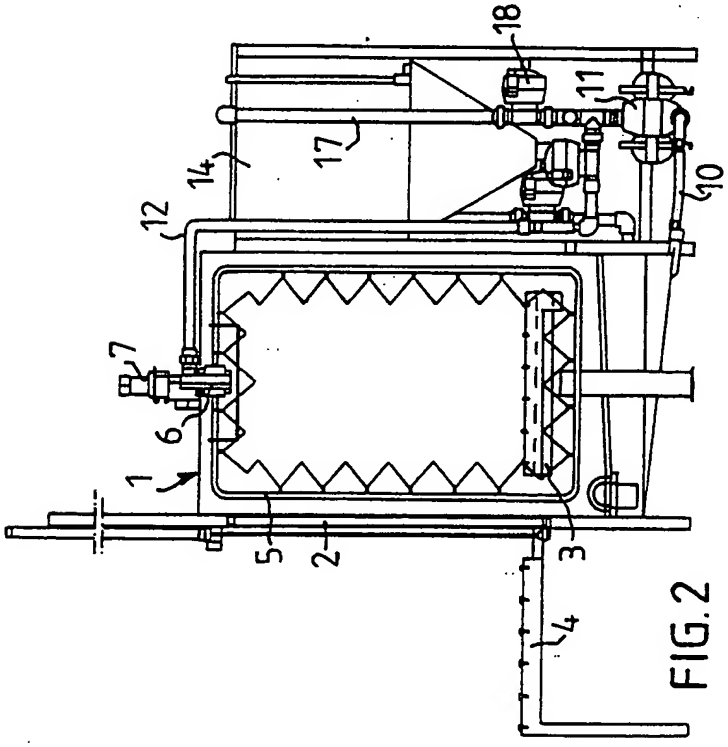

FIG.2

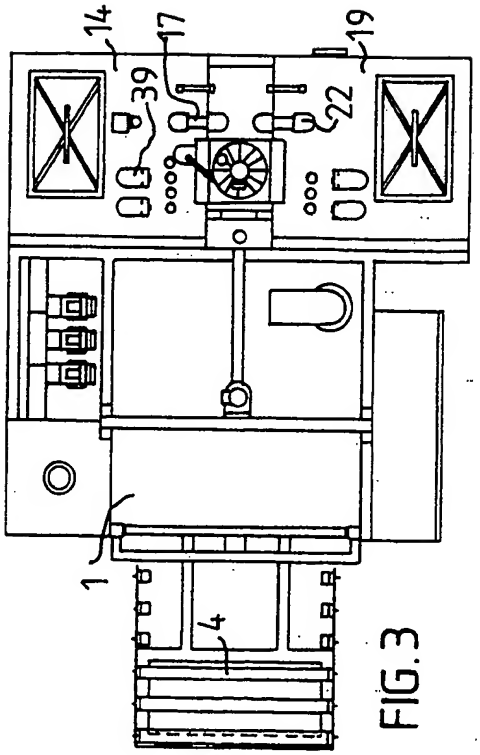

FIG.3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00183

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 08 B 3/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 08 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	NO, B, 157047 (OY HACKMAN AB) 5 October 1987, see the whole document	1-4
Y	--	5,6
Y	SE, A, 8801511 (L.A.H. HÅKANSSON) 22 March 1989, see claim 5	5
	--	
Y	GB, A, 2006913 (CERA INTERNATIONAL LIMITED) 10 May 1979, see the whole document	6
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14th October 1991	1991 -10- 16
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Hans Presto

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 91/00183

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 91-08-30 The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
NO-B- 157047	87-10-05	NONE		
SE-A- 8801511	89-03-22	AU-D-	2216388	89-03-23
		EP-A-	0309432	89-03-29
		JP-A-	1159387	89-06-22
GB-A- 2006913	79-05-10	NONE		